An Assessment of the Fall Vedder-Chilliwack River Sport Fishery, 1985

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by

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ABSTRACT

Hickey, D.G., I.W. Whyte and N.D. Schubert. 1987. An assessment of the fall Vedder-Chilliwack River sport fishery, 1985. Can. MS Rep. Fish. Aquat. Sci. 1908: 25 p.

The Vedder-Chilliwack River supports one of British Columbia's largest nontidal sport fisheries. During the fall, the fishery targets on coho salmon, although some effort has been directed towards chinook salmon since the river was reopened to the harvest of that species in 1984. Both populations are supplemented by releases of marked (adipose, pelvic and combined adipose-pelvic fin clips) and unmarked hatchery reared smolts. This study assessed the angler effort, harvest and release in the Vedder-Chilliwack River sport fishery from September 1 to December 15, 1985.

Separate estimates were made for sections of the river above and below Highway 1. Estimated effort above Highway 1 was approximately 56,000 angler-hours, peaking in October at 21,800 angler-hours. Estimated harvest above Highway 1 included 3,695 coho salmon (2,133 adults and 1,562 jacks), 334 chinook salmon (92 adult and 242 jacks), 14 pink salmon, 10 chum salmon, 319 rainbow trout, 16 steelhead trout, 10 cutthroat trout and 101 Dolly Varden char. Estimated releases included 1,775 coho salmon, 403 chinook salmon, 1,101 pink salmon, 4,359 chum salmon, 293 rainbow trout, 16 steelhead trout and 28 Dolly Varden char. An additional 12,300 angler-hours of effort were estimated for the river below Highway 1.

Marked coho accounted for 15% of returning adults and 69% of returning jacks. "Expo" coho (right pelvic fin clipped) accounted for 68% of returning jacks.

Key Words: sport fishery, Vedder-Chilliwack River, catch, angler effort, coho salmon.

RÉSUMÉ

Hickey, D.G., I.W. Whyte and N.D. Schubert. 1987. An assessment of the fall Vedder-Chilliwack River sport fishery, 1985. Can. MS Rep. Fish. Aquat. Sci. 1908: 25 p.

La riviére Vedder-Chilliwack alimente l'une des plus importantes pêches sportives dans des eaux sans marée de la Colombie-Britannique. À l'automne, la pêche vise le saumon coho quoiqu'un certain effort soit dirigé vers la pêche du saumon quinnat depuis qu'elle a été rouverte dans cette rivière en 1984. Les effectifs des deux espèces ont été augmentés par des lâchers de saumoneaux marqués (rognage des nageoires adipeuse, pelviennes et adipeuse-pelviennes) et non marqués d'élevage. La présente étude porte sur une évaluation de l'effort de pêche sportive, des prises et des lâchers au cours de la pêche sportive effectuée du 1er septembre au 15 décembre 1985 dans la rivière Vedder-Chilliwack.

Les auteurs présentent des estimations pour chaque section de la rivière en amont et en aval de la route 1. En amont, l'effort estimatif de pêche sportive se situe à environ 56 000 heures avec une pointe de 21 800 en octobre. Les prises estimatives s'élèvent à 3 695 saumons cohos (2 133 adultes et 1 562 jeunes mâles précoces), 334 saumons quinnats (92 adultes et 242 jeunes mâles précoces), 14 saumons roses, 10 saumons kétas, 319 truites arc-en-ciel, 16 truites arc-en-ciel anadromes, 19 truites fardées et 101 Dolly Varden. Les lâchers etimatifs comprennent 1 775 cohos, 403 quinnats, 1 101 roses, 4 359 kétas, 293 truites arc-en-ciel, 16 truites arc-en-ciel anadromes et 28 Dolly Varden. En aval de la route 1, l'effort estimatif de pêche sportive s'élève à 12 300 heures.

On a retrouvé 15 % de cohos marqués chez les adultes amontants et 69 % chez les jeunes mâles précoces amontants. Les cohos "expo", dont la nageoire pelvienne droite avait été rognée, représentaient 68 % des jeunes mâles précoces amontants.

Mots-clés: pêche sportive, rivière Vedder-Chilliwack, prises, effort de pêche sportive, saumon coho.

INTRODUCTION

The Vedder-Chilliwack River supports one of British Columbia's largest nontidal sport fisheries. Although considerable angler effort is directed toward coho salmon (**Oncorhynchus kisutch**), previous studies have focussed primarily upon steelhead (**Salmo gairdneri**) and cutthroat (**S. clarki clarki**) trout. For example, the winter steelhead fishery was assessed in 1984 (Clark and Facchin MS 1986) and 1985 (Scott and Lewynsky MS 1985); the late summer sea-run cutthroat fishery at the river mouth was assessed in 1984 (Scott MS 1985) and 1985 (Spence and Murray MS 1986). As well, steelhead catch, estimated from postcard questionnaires, is published annually by the B.C. Ministry of Environment (e.g. Billings 1986). A preliminary assessment of the fall coho salmon fishery was conducted between September and December, 1984 (DPA Group Inc. MS 1985a). Data from that survey were used in the design of the present study.

The 1985 Vedder-Chilliwack River sport fishery was assessed for three reasons. First, despite the existence of a relatively large coho sport fishery each fall, angler use and catch information was limited. The 1985 study was undertaken, therefore, to provide a more reliable assessment of this fishery. Second, the retention of adult chinook salmon was permitted in the Vedder-Chilliwack River between September 13 and October 31, 1985. This was the second year of an experimental fishery for chinook salmon (**O. tshawytscha**) adults, the only such opening in the Fraser River system since 1980. The 1985 survey was implemented to provide accurate estimates of the chinook salmon harvest, information critical to the evaluation of such experimental fisheries. Third, the Chilliwack River Hatchery substantially increased coho production in 1983 in response to effort increases in the marine sport fishery expected as a result of Vancouver's Expo 86. Most of that production was marked with an adipose and/or pelvic fin clip. The 1985 study, therefore, provided an opportunity to assess the return of precocious males (jacks) from that release, as well as to provide effort and harvest rate data to compare with a 1986 fishery harvesting a dramatically larger coho stock.

This report describes the study design and field procedures and documents the results of the 1985 Vedder-Chilliwack River sport fishery survey. The report presents detailed monthly estimates of angler effort, harvest and release by species and mark type, and angler characteristics. The report concludes with a discussion of potential bias in the analytic techniques used in this study.

STUDY AREA DESCRIPTION

The Vedder-Chilliwack River originates in the Cascade Mountains of Washington State. It flows north into Chilliwack Lake (B.C.), then continues in a westerly direction for 61 kilometres, entering the Sumas River and subsequently the Fraser River near Chilliwack (Fig. 1). Below Slesse Creek, the river is open to angling year-round, except for a closure from May 1 to June 30 intended to conserve steelhead trout (Ministry of Environment 1985). From Slesse Creek upstream to Chilliwack Lake, the river is closed to angling to protect wild steelhead trout.

For the purpose of this study, the river was divided into four regions (Fig. 1). Region 1 included the Vedder and Sumas rivers from the Highway 1 bridge downstream to the Fraser River confluence. Because of limited shore access, most angling in this relatively short region was conducted from boats.

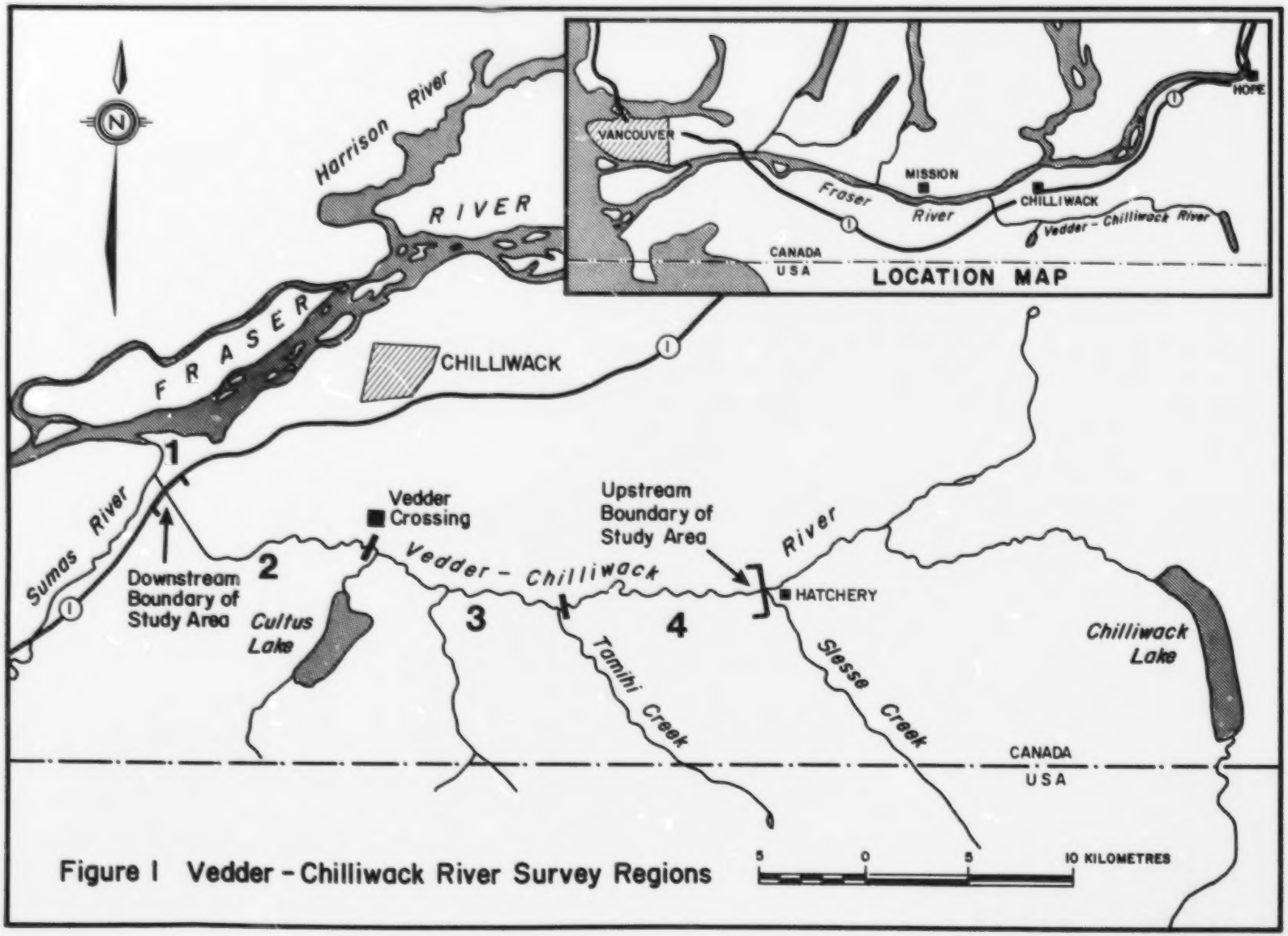

Figure 1 Vedder - Chilliwack River Survey Regions

Region 2 extended from the Highway 1 bridge upstream to the bridge at Vedder Crossing. In this region, the river is diked to provide flood control and channel stability. The lower, narrow section of diked stream is known locally as the Vedder Canal. Roads running along the dikes provide direct river access through the entire region.

Region 3 extended from Vedder Crossing upstream to the Tamihi Creek Bridge, while Region 4 extended from the Tamihi Creek Bridge to the mouth of Slesse Creek. In both regions, the Chilliwack Lake Road provides frequent access points to the river, especially at campground and picnic areas. The Chilliwack River Hatchery is located immediately upstream from Slesse Creek.

METHODS

STUDY DESIGN

The 1985 Vedder-Chilliwack River sport fishery was assessed, using a roving creel study design (Malvestuto **et al.** 1978), between September 1 and December 15, 1985. The design entailed monthly assessment periods which were separated into weekday and weekend/holiday strata. The sampling schedule included all weekend/holiday days and three weekdays per week. A single creel clerk worked one of two randomly selected eight hour shifts which encompassed all daylight hours, with actual times adjusted each month to reflect decreasing day length. Data were recorded by region of angler encounter; however, for the purpose of analysis, all data were pooled because the highly mobile nature of the fishermen precluded separation of effort and catch per unit effort by region.

On each sampling day, the creel clerk travelled a predetermined route by automobile with a randomly selected start point and direction of travel. Survey effort was apportioned equally between study regions. Anglers were approached on foot and interviewed regarding the length of time angling (to time of interview and additional expected time, to the nearest half hour), target species, number and species of fish harvested or released, identifying marks on harvested fish (adipose, pelvic or maxillary clip) and gear type. When possible, the harvest was inspected to confirm species and mark identification. An interview form was completed for every angler encountered; however, if the angler was unresponsive or if response reliability was questionable, the form was voided. Each sampling day consisted of three two-hour periods in which angler interviews were conducted in each of the three survey regions (regions 2-4). An additional, randomly selected one and one half hour period was used to conduct an "instantaneous" rod count of the entire study area (regions 2-4). No interviews were conducted during this period.

The study was designed to estimate angler effort, catch per unit effort and total catch (harvest and release). Angler effort was determined from a combination of angler interview and rod count data. Catch per unit effort was determined from angler interview data alone. Total catch (harvest and release) was determined from angler effort and catch per unit effort estimates.

Angler effort in Region 1 was estimated from angler counts made from a Cessna 172 aircraft. These counts numbered eight in September, nine in October, five in November and two in December.

DATA MANAGEMENT

Data storage and analyses were conducted on an IBM-XT compatible microcomputer. A custom designed data entry program (DPA Group Inc. MS

1985b) was used to generate ASCII data files which were subsequently imported into a spreadsheet program (Lotus 1-2-3)[1] for analysis. Monthly data files were sorted by weekday and weekend/holiday strata prior to further analysis.

The data were verified in two ways. First, a sample of all field data sheets were examined to ensure compliance with study procedures. Second, the data entry software performed 31 automatic error checks, including duplication detection, code validity, and range and consistency verification. This eliminated the need for further verification.

DATA ANALYSES

Angler Effort

Regions 2-4: Profiles of hourly angler effort were generated for each month/day-type stratum from angler interview data. Hourly effort was weighted to compensate for the sampling imbalance which resulted from overlapping survey shifts.

Total sample-day angler effort (angler-hours) was calculated by dividing the rod count by the proportion of the daily effort occurring in that time block. Early morning and late afternoon rod counts were excluded since the tails of the effort profiles were extremely sensitive to minor deviations from mean conditions and could potentially produce substantial error. Mean daily angler effort (and its variance) was calculated for each month/day-type stratum. Strata totals were the product of the mean daily angler effort and the number of days in each stratum. Total monthly and study period angler effort and associated variances were produced by combining stratum totals and stratum variances. The mathematical relationships, based on Mendenhall **et al.** (1971), are:

1) Estimated mean daily effort ($\bar{e}$):

$$\bar{e} = \left(\sum_{i=1}^{n} c_i/p\right) / n$$

2) Total monthly/study period effort (E):

$$E = \sum_{i=1}^{L} \bar{e}_i N_i$$

3) Confidence limit (95%) for total monthly/study period effort (CL):

$$CL = \pm t\sqrt{\sum_{i=1}^{L} (N^2{}_i)[V(\bar{e}_i)/n_i][(N_i-n_i)/N_i]}$$

where c_i= rod count on day i at hour x,
p = proportion of total daily effort in hour x,
n = number of sample days in the stratum,
N_i= number of days in stratum,
t = "t" value at 95% significance level and n-1 degrees of freedom,
L = number of strata,
$V(\bar{e})$ = variance of mean daily effort.

Region 1: Angler effort in Region 1 was estimated as above, except region 2-4 effort profiles were applied to Region 1 overflight angler counts. Variances were not calculated due to uncertainty in the assumption that effort profiles in the two areas were similar.

Catch Per Unit Effort

Catch per unit effort (CPUE) was calculated by species and mark group for each month/day-type stratum using a total ratio estimator (Von Geldern, Jr. and Tomlinson 1973; Malvestuto 1983), i.e. the total observed catch was divided by the total observed effort (to time of interview). CPUE was calculated separately for harvest-

[1] - Lotus and 1-2-3 are registered trademarks of Lotus Development Corporation.

ed (HPUE) and released (RPUE) fish; however, RPUE was not calculated for marked fish because angler mark recognition was considered unreliable. The appropriate variance estimator was derived from Snedecor and Cochran (1980). CPUE's and their variances were calculated as follows:

4) Catch per unit effort (CPUE):

$$CPUE = \sum_{i=1}^{A} c_i \; / \sum_{i=1}^{A} t_i$$

5) Variance for CPUE's (V(CPUE)):

$$V(CPUE) = (1/\bar{t})\sqrt{\frac{(c_i-(CPUE)t_i)^2}{n(n-1)}}$$

where A = number of anglers interviewed in stratum,
c_i = observed catch of angler i,
t_i = time to interview for angler i,
$\bar{t}$ = mean time spent angling (to time of interview),
n = number of anglers interviewed in stratum.

Harvest and Release

Total harvest and release, estimated by species/mark group for each month/day-type stratum, was the product of stratum effort and the corresponding value of HPUE or RPUE. These data were summed to produce estimates of total monthly and study period harvest and release. Harvest and release estimates were not computed for Region 1 since catch rates for regions 2-4 were not considered representative of Region 1. The relationships used were:

6) Total monthly/study period catch (C):

$$C = \sum_{i=1}^{L} (E_i)(CPUE_i)$$

7) Confidence limits (95%) for total monthly/study period catch:

$$CL = \pm (t)\sqrt{\sum_{i=1}^{L} V(C)_i}$$

where E = total effort for month/day-type stratum,
CPUE = catch per unit effort for species/mark group and month/day-type stratum.
L = number of strata,
$V(C)_i$ = variance of estimated catch in stratum i,
$= E_i^2[V(CPUE_i)]+CPUE_i^2[V(E_i)]+[V(CPUE_i)][V(E_i)]$
t = "t" value

Harvest Rate

Harvest rates were calculated for each species/mark group by dividing the estimated total harvest by the sum of the estimated total harvest and the observed escapement of that species/mark group. Escapement included both returns to the Chilliwack River Hatchery and escapement to the Vedder-Chilliwack River system spawning areas (Farwell **et al.** MS 1987). Because monthly return estimates were unavailable, only annual harvest rates were calculated.

Awareness Factor

A portion of the hatchery reared salmon were marked by the removal of the adipose fin, indicating the presence of a coded wire tag. Sport anglers were requested to return the head of any adipose clipped fish to designated depots for subsequent dissection and tag recovery. The awareness factor for each species was calculated as the ratio of the number of heads returned and the estimated total harvest of adipose clipped fish. Because the age of those heads from which tags were not recovered (no pin or lost pin) was unknown, the jack/adult ratio was estimated from the sample from which tags were recovered.

Angler Characteristics

The following angler attributes were summarized by month/day-type stratum: mean angler-day length (hours) for all anglers; mean angler-day length by weather type (clear, overcast and rain); mean angler-day length from complete and incomplete trip interviews; number of anglers targeting on each species; and preferred gear type.

RESULTS

SURVEY EFFORT

A total of 2,339 angler interviews were conducted during the study, with 255, 1,020, 749 and 315 conducted in September, October, November and December, respectively (Appendix 1). The sampling schedule included 32 weekdays and 29 weekend/holiday days, accounting for 44% and 85% of the study period weekdays and weekend days, respectively. The proportion of weekdays surveyed ranged from 30% in September to 50% in each of the other three months, while the proportion of weekend days surveyed increased from 70% in September to approximately 90% in October and November. All weekend days between December 1 and 15 were sampled.

ANGLER EFFORT

Daily Angler Effort Profiles

Profiles of daily angler effort for weekdays and weekend/holiday days are detailed in Appendix 2. Over 95% of angler effort occurred between 0700h and 1800h. Peak angler effort occurred between 1100h and 1400h.

Monthly Angler Effort

Regions 2-4: Angler effort in regions 2-4 totalled approximately 56,000 angler-hours (Table 1), with 95% confidence limits of ± 8.8% (Appendix 3). Estimated effort by month totalled 8,286, 21,753, 16,664 and 9,283 angler-hours in September, October, November and December, respectively (Fig. 2). Mean daily effort peaked during October when angler effort was estimated at 589 and 979 angler-hours per day for weekday and weekend days, respectively. Mean daily effort on weekend/holiday days was approximately double that on weekdays; however, 52% of the total study

Table 1. Estimated angler effort (hours) by month and region in the Vedder-Chilliwack River, September 1 to December 15, 1985.

Region	September	October	November	December [a]	Total
Region 2 - 4	8,286	21,753	16,664	9,283	55,986
Region 1	5,910	5,276	839	275	12,300
Total	14,196	27,029	17,503	9,558	68,286

[a] December 1 - 15 only

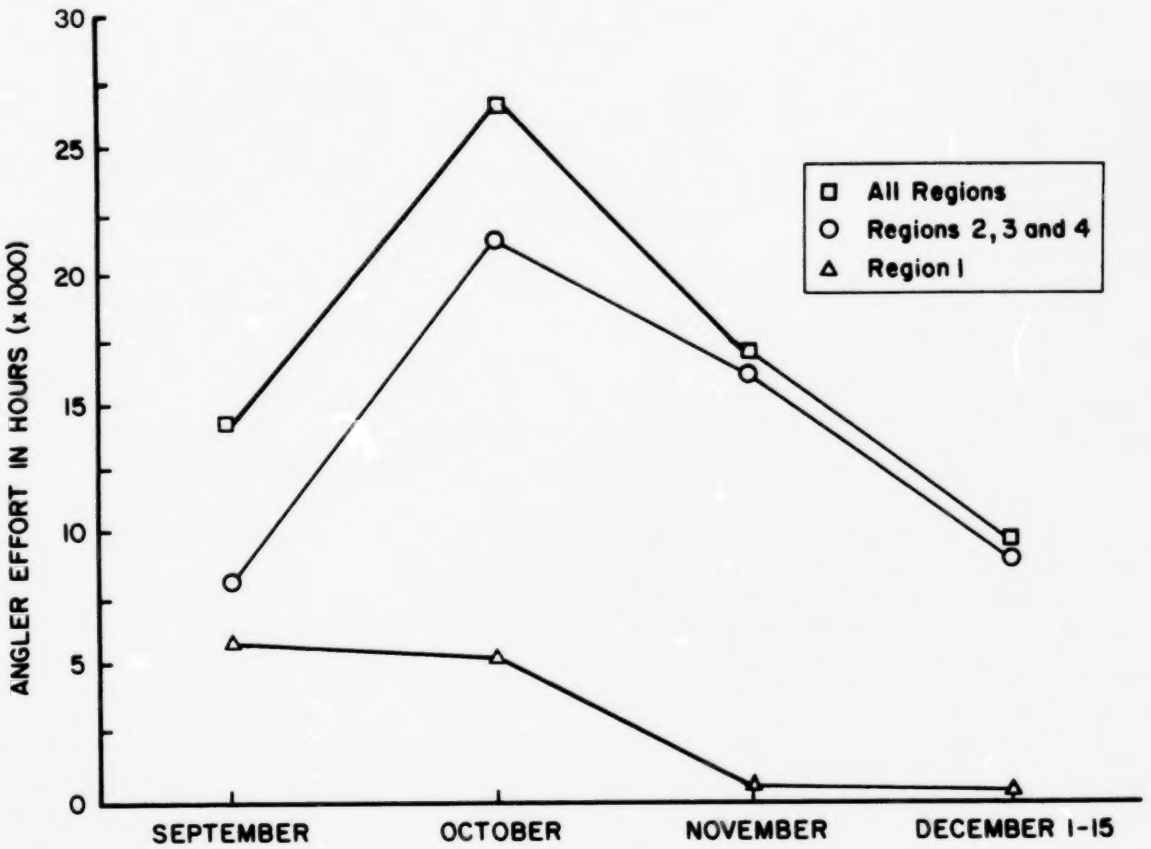

Figure 2 Distribution of Angler Effort on the Vedder-Chilliwack River between September 1 and December 15, 1985.

period effort occurred on weekdays (Appendix 3). Coefficients of variation for estimates of total monthly angler effort ranged from 11.8 to 19.8. The coefficient of variation for the total study period estimate of effort was 7.5.

Region 1: Angler effort in Region 1 totalled approximately 12,300 angler-hours (Table 1), with over 90% (11,200 angler-hours) of the effort having occurred in September and October (5,900 and 5,300 angler hours, respectively). Effort peaked in September and declined sharply after October (Fig. 2).

CATCH PER UNIT EFFORT

Harvest

Estimated HPUE (expressed as fish per hour) for all species and mark-groups is presented by month/day-type stratum in Appendix 4. Maximum HPUE's for combined marked and unmarked coho adults (0.0778) and jacks (0.0655) occurred during November weekdays and October weekdays, respectively. Maximum HPUE's for chinook adults (0.0044) and jacks (0.0077) occurred during October weekdays. Rainbow trout (including steelhead smolts) were harvested at a peak rate of 0.0755

fish per hour during September weekdays. Harvested fish also included pink (**O. gorbuscha**) and chum (**O. keta**) salmon, cutthroat and steelhead trout, and Dolly Varden char (**Salvelinus malma**).

Release

Estimated RPUE for all species is presented in Appendix 4. Coho adults and jacks were released at maximum rates of 0.0777 and 0.0226 fish per hour, respectively, during December and November weekdays. Chinook adult (0.0127) and jack (0.0100) release rates were greatest on November weekdays and October weekdays, respectively. High release rates were observed for pink salmon (maximum 0.0511 fish per hour on October weekdays) and chum salmon (maximum 0.1636 fish per hour on December weekdays).

HARVEST BY SPECIES

Total harvest by species and mark group is presented in Table 2. These estimates are for regions 2-4 only.

Coho Salmon

The total harvest of coho salmon was estimated at 3,695 (2,133 adults and 1,562 jacks). The maximum monthly coho adult harvest of 1,036 occurred in November; the maximum monthly coho jack harvest of 1,131 occurred in October (Fig. 3).

Adipose clipped coho adults comprised 15.1% (322) of the total coho adult harvest. Monthly proportions ranged from 0% in September to 18.8% (37) during December. Adipose clipped coho jacks comprised 0.9% (14) of the total coho jack harvest. Right pelvic fin clipped coho jacks comprised 67.7% (1,058) of the total coho jack harvest. Monthly proportions ranged from 40.0% (38) in September to 71.1% (804) in October.

Over the entire study period, the ratio of observed (examined) to estimated coho harvest averaged 10.8% and 11.7% for adults and jacks, respectively (Appendix 5).

Chinook Salmon

The total harvest of chinook salmon was estimated at 334 (92 adults and 242 jacks). The maximum monthly chinook adult and jack harvest of 75 and 136, respectively, occurred in October.

No marked chinook adults were observed during the study. The estimated harvest of adipose fin clipped jacks was 23 fish, or 9.5% of the chinook jack harvest.

Other Species

Chum and pink salmon harvest was estimated at 10 (all in September) and 14 (all in October), respectively. Retention of either species is illegal in nontidal waters.

The trout harvest included 319 rainbow (including steelhead smolts), 16 steelhead and 10 cutthroat (all adipose fin clipped). The harvest of Dolly Varden char was estimated at 101.

RELEASE BY SPECIES

Release by species in regions 2-4 is presented in Table 2.

Coho Salmon

The total release of coho salmon was estimated at 1,775 (1,249 adults and 526 jacks). Maximum monthly releases of 583 adults and 271 jacks occurred in December and October, respectively.

Chinook Salmon

An estimated 403 chinook (215 adults and 188 jacks) were released

Table 2. Estimated harvest and release by species and month in the Vedder-Chilliwack River (regions 2-4), September 1 to December 15, 1985 (95% confidence limit in parenthesis).

	September		October		November		December		Total	
A. Harvested Fish										
Coho	138	(93)	655	(197)	858	(233)	160	(97)	1,811	(333)
Coho (AD)	0	-	107	(62)	178	(92)	37	(50)	322	(122)
Coho jack	57	(45)	313	(130)	120	(70)	0	-	490	(154)
Coho jack (RP)	38	(53)	804	(238)	216	(104)	0	-	1,058	(265)
Coho jack (AD)	0	-	14	(24)	0	-	0	-	14	(24)
Chinook	10	(19)	75	(52)	7	(13)	0	-	92	(56)
Chinook jack	52	(47)	132	(72)	35	(51)	0	-	219	(100)
Chinook jack (AD)	0	-	4	(19)	19	(27)	0	-	23	(33)
Pink	0	-	14	(24)	0	-	0	-	14	(24)
Chum	10	(19)	0	-	0	-	0	-	10	(19)
Steelhead	0	-	0	-	0	-	16	(22)	16	(22)
Rainbow	284	(187)	28	(35)	7	(13)	0	-	319	(191)
Cutthroat (AD)	10	(19)	0	-	0	-	0	-	10	(19)
Dolly Varden	28	(33)	61	(43)	12	(23)	0	-	101	(59)
B. Released Fish										
Coho	38	(46)	138	(110)	490	(206)	583	(293)	1,249	(377)
Coho jack	14	(29)	271	(148)	233	(145)	8	(16)	526	(209)
Chinook	10	(19)	66	(62)	139	(91)	0	-	215	(112)
Chinook jack	14	(28)	151	(81)	23	(33)	0	-	188	(92)
Pink	170	(107)	895	(500)	36	(42)	0	-	1,101	(513)
Chum	10	(19)	1,154	(395)	2,009	(509)	1,186	(557)	4,359	(852)
Steelhead	0	-	0	-	0	-	16	(22)	16	(22)
Rainbow	265	(215)	28	(35)	0	-	0	-	293	(218)
Dolly Varden	19	(26)	9	(12)	0	-	0	-	28	(29)

AD = Adipose fin clipped
RP = Right pelvic fin clipped

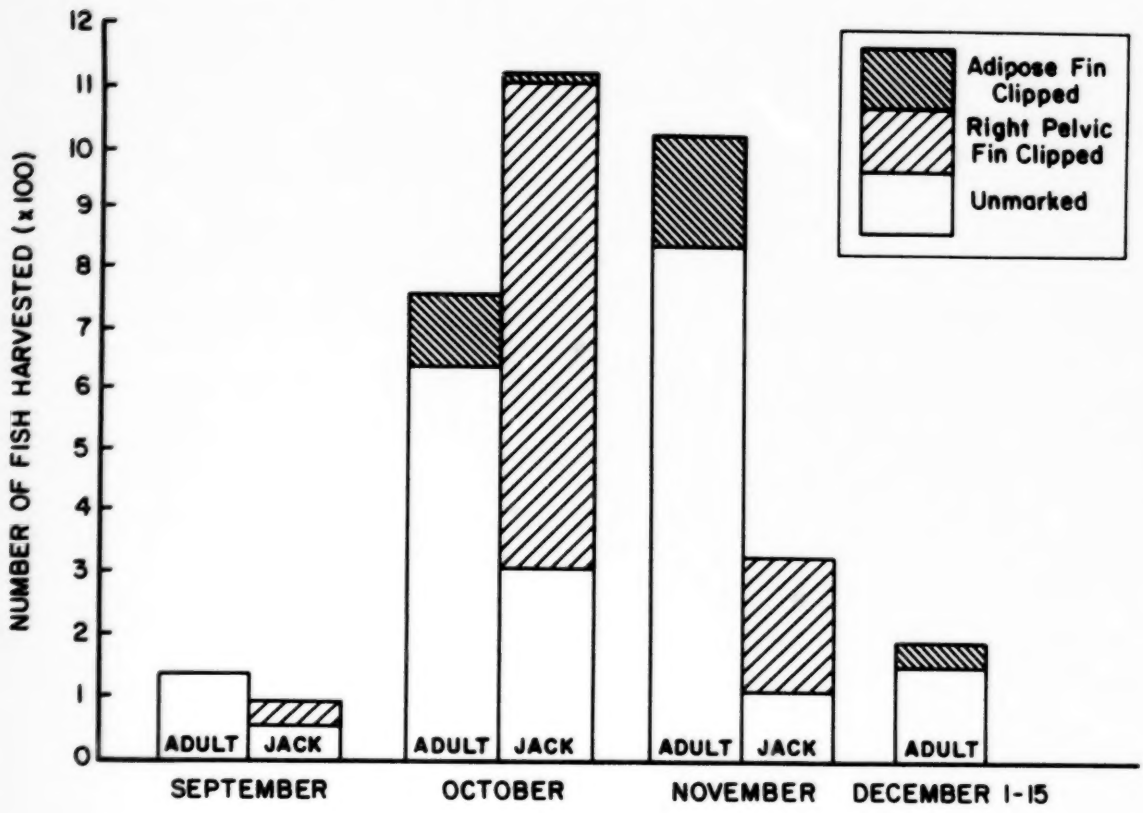

Figure 3 Estimated Harvest of Coho Salmon from the Vedder-Chilliwack River between September 1 and December 15, 1985.

during the study. Maximum monthly releases of 139 adults and 151 jacks occurred in November and October, respectively.

Other Species

An estimated 4,359 chum salmon were released during the study period. Releases were numerous in October, November and December, totalling 1,154, 2,009 and 1,186, respectively. Pink salmon releases were estimated at 1,101, with most (895) occurring in October. Estimated releases of rainbow trout, steelhead trout and Dolly Varden char were 293, 16 and 28, respectively. No cutthroat trout were reported released.

HARVEST RATE

The harvest rate for both unmarked and marked (adipose clipped) coho adults was 5.5% (Table 3). Marked coho jacks were harvested at rates of 10.5% and 9.6% for adipose and right pelvic clipped fish, respectively. No coho jacks with both adipose and pelvic clips were observed by the creel surveyor.

Unmarked chinook adults were harvested at a rate of 8.3%; no marked

Table 3. Estimated 1985 harvest rates and awareness factors for Vedder-Chilliwack River coho and chinook salmon.

	Catch	Escapement			Harvest Rate (%)	Heads Returned	Awareness Factor
		Natural[a]	Hatchery	Total			
Coho	1,811	14,724	16,352	31,076	5.5	-	-
Coho (AD)	322	-	5,841	5,841	5.5	136	0.422
Coho jack (AD)	14	-	119	119	10.5	1	0.071
Coho jack (RP)	1,058	-	9,925	9,925	9.6	-	-
Chinook	92	850	168	1,018	8.3	-	-
Chinook jack (AD)	23	-	25	25	47.9	2	0.087

[a] Adults only; escapement was not examined for marks.

chinook adults were observed. The observed harvest rate of marked (adipose clipped) chinook jacks was 47.9%.

Unmarked coho and chinook jacks were not enumerated in the spawning escapements; therefore, harvest rates were not calculated.

AWARENESS FACTOR

The awareness factors for adipose clipped coho adults and jacks were estimated at 0.422 and 0.071, respectively (Table 3). No adipose clipped chinook adults were observed during the study. The awareness factor for chinook jacks was estimated at 0.087. No steelhead trout were returned to any head depot during the first two weeks of December, 1985.

ANGLER CHARACTERISTICS

Average Angler-day Length

Angler-day length averaged 5.05 hours for all anglers interviewed during the study period (Table 4). Weather did not influence average angler-day length (Appendix 6); however, a substantial difference was noted in the average angler-day length between complete and incomplete trip interviews. Only 8.4% (197) of the anglers interviewed had ceased angling for the day at the time of the interview. These anglers reported fishing an average of 3.72 hours. The remaining anglers (2,142), who were interviewed part-way through their trip, estimated they would fish for an average of 5.15 hours.

Target Species

Anglers were primarily interested in catching either coho salmon (68%) or "any salmon or trout" (25%) during the September to mid-December study period (Table 4). Coho were the primary target species until early December, when steelhead trout became the primary target species of 40% of the anglers.

Table 4. Summary by month of angler-day length, preferred species and gear in the Vedder-Chilliwack River sport fishery, September 1 to December 15, 1985.

	September	October	November	December	Total[a]
Mean angler-day (hrs)					
- incomplete trip	4.86	5.31	5.11	5.09	5.15
- complete trip	4.22	3.99	3.54	2.97	3.72
- all interviews	4.76	5.16	5.07	5.02	5.05
Target species (% of effort)					
- coho	42.3	80.9	90.2	19.1	67.7
- steelhead	1.2	0.7	0.9	39.5	7.3
- any salmon or trout	54.9[b]	18.4	8.9	41.4	24.8[b]
Gear (% of effort)					
- bait	60.2	60.0	49.0	18.9	49.9
- bait and lure	7.4	8.9	11.3	24.7	12.1
- fly	5.4	2.5	2.7	2.2	2.9
- lure	27.0	28.6	37.0	54.2	35.1

[a] weighted by monthly angler effort.
[b] does not include anglers targeting on chinook salmon, cutthroat or rainbow trout.

Gear Type

Bait-angling was the most commonly used method (50%), followed by lure (35%), baited lure (12%) and fly (3%) (Table 4). Gear preference was relatively constant until December, when lures were the gear preferred by 54% of the anglers.

DISCUSSION

OVERVIEW OF THE FALL FISHERY

General

The fall Vedder-Chilliwack River sport fishery targeted primarily on coho salmon, with the exception of a small sea-run cutthroat trout fishery in Region 1 during September. The catch of other species during this period was largely incidental to coho. During December, however, angler effort shifted from coho salmon to steelhead trout, a change reflected in the target species and gear information collected by this study. Between November and December, the proportion of anglers fishing for steelhead increased from 1% to 40% and the proportion fishing with lures increased from 37% to 54%. The steelhead fishery normally continues through April, with an average 73,000 angler-hours effort recorded between January and April in 1984 and 1985 (Scott and Lewynsky MS 1985).

Angler effort during the 1985 coho fishery totalled 68,300 angler-hours (56,000 in regions 2-4), an increase of 67% over the level estimated during the 1984 preliminary study. It is uncertain, however, if this difference reflects a true effort increase or is simply an artifact of improved assessment procedures. Angler effort peaked in October, one month earlier than the peak coho adult catch and CPUE but coincident with peak coho jack catch and CPUE, probably indicating an earlier jack return timing. The portions of the total coho jack and adult catch which were harvested both peaked one month prior to the respective peak catches, in September (87%) and October (85%), respectively, and declined sharply after that time. Because target species preference did not follow a similar pattern, these data suggest a sharp decline in fish quality after October.

Chinook salmon

The opening of the Vedder-Chilliwack River to the retention of adult chinook salmon was largely unsuccessful in attracting additional angler effort. Although total angler effort may have been greater than the previous year, there is little indication of an effort response to the chinook opening. Only three (0.1%) of the 2,339 anglers interviewed specifically identified chinook adults as their target species. This contrasts with 68% and 7% of the anglers who fished specifically for coho and steelhead, respectively. As well, only 30% of the chinook adults and 56% of the chinook jacks which were caught were actually retained. This includes only 53% of the chinook adults landed in September and October, the period when fish quality was highest. These data may reflect a reluctance by the angler to forego the opportunity to fill the daily bag limit with the target species by harvesting a less preferred white fleshed chinook adult, or possibly a carry-over of conservation concerns from previous years.

ESTIMATION OF EFFORT

The precision of angler effort estimates can be improved by using effort profiles generated from interview data because the technique permits greater stratification of the sample day and most hourly strata are sampled each day. In contrast, techniques such as nonuniform probability sampling tend to be less precise because they use much larger time strata (AM and PM units in some cases) which are sampled less frequently.

Accuracy in effort estimation using effort profiles depends on estimating the effort profile without bias. The 1985 study was designed to provide a representative sample of the fishery: all encountered anglers were interviewed; daily survey start point and direction of travel were randomized; and each hourly time block was sampled. Of potential concern, however, was the observed difference in angler-day length estimated from complete (3.72 hours) and incomplete (5.15 hours) trip interviews. Assuming the probability of encountering an angler leaving the river was independent of trip length, angler-day length estimated from complete trip interviews should accurately reflect true angler-day length. The positive bias observed in the incomplete trip estimate has two possible sources. First, anglers contacted while fishing may inaccurately estimate total trip length; however, although total trip length may be estimated with error, it is unlikely that such estimates would be biased. This factor, therefore, was unlikely to influence either the angler-day estimate or the effort profile. Second, roving surveys are susceptible to a length of stay bias (Lucas 1963; Sinclair and Morley 1975), i.e. the probability of encounter is higher for anglers who fish longer. Length of stay bias may

account for most of the observed 1.4 hours difference in the angler-day estimates; however, this does not imply a systematic bias in the estimate of daily effort. A representative sample from a population of anglers fishing differing periods of time would be expected to select individuals roughly in proportion to the amount of time fished. Because the probability of contact is not equal for all anglers, such a sample would produce a biased estimate of angler-day length but an unbiased estimate of daily angler effort.

In summary, although angler-day length was estimated with bias, the bias was unlikely to have influenced either the effort profile or the estimate of total angler effort.

ESTIMATION OF CATCH

Catch per unit effort (CPUE) was calculated using a total ratio estimator, a self weighting technique where total observed catch of a particular species group was divided by the total observed effort of all interviewed anglers. Other studies have used mean of ratios estimators which give equal weight to daily CPUE estimates. Variances associated with the former approach are higher because they are based on a large number of highly variable samples, while the latter method stratifies CPUE information by day, lowering the variability of the data set. While the total ratio estimator used to calculate study CPUE's resulted in greater variance in the catch estimates, it was felt to be more appropriate than the mean of ratios estimator because the estimate is weighted to daily differences in CPUE and reflects between-angler variability.

HARVEST RATE

The reliability of the harvest rate estimates was limited by three factors. First, the natural spawning areas were surveyed using visual techniques which tend to underestimate escapement. These estimates, therefore, were less accurate than the hatchery return estimate. Second, the escapement of jacks was recorded only at the hatchery; returns to the natural spawning areas were not estimated. Third, the stray rate of fin clipped hatchery returns is unknown because the natural spawning areas were not examined for fin clips.

Because of differences in behaviour, the above factors have a different impact on each species. For example, cultured chinook salmon tend to spawn primarily in the Vedder-Chilliwack mainstem, with only a small proportion of the escapement returning to the hatchery. Since the river escapement does not include jacks and may underestimate adults, the jack harvest rate reported in Table 3 (47.9%) is probably a gross overestimate and the adult harvest rate (8.3%) a slight overestimate. In contrast, coho salmon tend to stray from the release site at a lower rate. For example, Schubert and Lister (1986) reported a stray rate of only 0.8% in Salwein Creek coho adults returning to the Chilliwack River Hatchery in 1983. Bias in the coho adult (5.5%) and marked jack (9.6%) harvest rates, therefore, is likely insignificant.

The estimated harvest rate of coho jacks was almost double that of adults, possibly due to behavioural differences which make jacks more vulnerable to sport gear. Other factors, such as a higher relative stray rate in jacks, which would result in a positive bias in the jack harvest rate, or an overestimate of the adult escapement to natural spawning areas, which would result in a negative bias in the (unmarked) adult harvest rate, were considered and rejected. The former was rejected because previous studies of chinook (Quinn and Fresh 1984) and Salwein Creek coho (Schubert

and Lister 1986) reported lower stray rates in jacks relative to adults; the latter because the harvest rate estimated for marked hatchery adults was identical to that of unmarked adults.

AWARENESS FACTOR

The 1985 awareness factor for adipose clipped coho adults harvested in the Vedder-Chilliwack River was estimated at 0.422. This was considerably higher than the 0.262 awareness factor in the Georgia Strait sport fishery (English **et al.** 1986), probably reflecting the public relations impact of a major enhancement facility in the watershed and the convenient location of several head recovery depots on the river.

The reliability of awareness factor estimates for coho jacks and chinook jacks and adults was limited due to small samples sizes. Although the awareness factor for jacks was approximately one-fifth that of coho adults, it is unclear if this represents a lesser tendency of sport fishermen to return jack heads to the head recovery depots or if it is an artifact of small sample size.

ASSESSMENT OF REGION 1

The use of effort profiles from regions 2-4 to generate effort estimates for Region 1 assumed that effort profiles for the two areas were similar. This assumption was supported by data collected during August and September, 1985 (Spence and Murray MS 1986) which provided profiles similar to those collected by the current study. If angler success rates were also similar, then the study period coho catch in Region 1 would total 500 (230 adults and 270 jacks); however, these projections should be interpreted with caution. Spence and Murray (MS 1986) reported no coho catch and only 2.5% of the anglers targeting on coho during the August 15 to September 15 study. Although angler effort remains high after the cutthroat trout fishery, suggesting a change to coho fishing, the application of regions 2-4 CPUE data to Region 1 effort estimates would not be appropriate for all months.

SUMMARY

1. The fall coho sport fishery in the Vedder-Chilliwack River was assessed, using a roving creel study design, between September 1 and December 15, 1985. Angler-effort was estimated both above (regions 2-4) and below (Region 1) Highway 1; catch was estimated only above Highway 1.

2. A single surveyor, working 32 weekdays and 29 weekend/holiday days, recorded the following during 2,339 angler interviews: length of time angling, target species, number and species of fish harvested or released, identifying marks on harvested fish, and gear type.

3. Angler effort was estimated by applying instantaneous rod counts to hourly angler effort profiles generated from interview data. Factors influencing the accuracy of the effort estimate were discussed.

4. Study period angler effort in regions 2-4 totalled 56,000 angler-hours, with 95% confidence limits of ± 8.8%. An additional 12,300 angler-hours were estimated in Region 1.

5. Study period harvest totalled 3,695 coho (2,133 adults and 1,562 jacks), 334 chinook (92 adults and 242 jacks), 10 chum, 14 pink, 319 rainbow, 16 steelhead, 10 cutthroat and 101 Dolly Varden.

6. Study period release totalled 1,775 coho (1,249 adults and 526 jacks), 403 chinook (215 adults and 188 jacks), 4,359 chum, 1,101 pink, 293 rainbow, 16 steelhead and 28 Dolly Varden.

7. Adipose fin clipped coho adults comprised 15.1% of the coho adult harvest. Adipose and right pelvic fin clipped coho jacks comprised 0.9% and 67.7%, respectively, of the coho jack harvest.

8. The harvest rate of coho adults in the Vedder-Chilliwack River sport fishery was 5.5%. The harvest rate of marked coho jacks was higher, estimated at 9.6%.

9. The awareness factor for adipose clipped coho adults of 0.422 was considerably higher than in the Georgia Strait sport fishery. The awareness factor for coho jacks was only 0.071.

10. The opening of the Vedder-Chilliwack River to the retention of adult chinook salmon was unsuccessful in attracting angler effort. Only three of the 2,339 anglers interviewed identified chinook adults as their preferred species, and only 30% of the chinook adults landed were actually retained.

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C.R. Harrison provided review comments, R. Reimer typed the manuscript and S. Galenzowsky drafted the figures.

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APPENDICES

APPENDIX 1. VEDDER-CHILLIWACK RIVER SPORT FISHERY SURVEY EFFORT, SEPTEMBER 1 TO DECEMBER 15, 1985.

	September	October	November	December	Total
Shifts worked:					
Weekdays -	6	11	10	5	32
Weekends -	7	8	9	5	29
Days in month:					
Weekdays -	20	22	20	10	72
Weekends -	10	9	10	5	34
Percentage of days worked:					
Weekdays -	30	50	50	50	44
Weekends -	70	89	90	100	85
No. of angler interviews:					
Weekdays -	75	398	286	109	868
Weekends -	180	622	463	206	1,471
Total -	255	1,020	749	315	2,339

Note: Weekends include statutory holidays.

APPENDIX 2. ANGLER EFFORT PROFILES FOR THE VEDDER-CHILLIWACK RIVER SPORT FISHERY, SEPTEMBER 1 TO DECEMBER 15, 1985.

	Proportions of total daily effort by hour							
	September		October		November		December	
Hour	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd
0400-0459	-	-	-	-	-	0.0003	-	-
0500-0559	0.0033	0.0100	0.0071	0.0095	-	0.0003	-	-
0600-0659	0.0372	0.0614	0.0494	0.0477	0.0051	0.0013	0.0090	0.0081
0700-0759	0.0609	0.0865	0.0788	0.0835	0.0556	0.0779	0.0451	0.0497
0800-0859	0.0709	0.0928	0.1012	0.1025	0.0808	0.1034	0.1065	0.0940
0900-0959	0.0946	0.1092	0.1153	0.1399	0.1060	0.1210	0.1282	0.1239
1000-1059	0.1149	0.1117	0.1129	0.1431	0.1175	0.1268	0.1733	0.1555
1100-1159	0.1318	0.1079	0.1200	0.1357	0.1307	0.1272	0.1733	0.1655
1200-1259	0.1418	0.1092	0.1212	0.1161	0.1255	0.1194	0.1354	0.1555
1300-1359	0.1183	0.0890	0.1153	0.0938	0.1026	0.0948	0.0939	0.1184
1400-1459	0.0744	0.0718	0.0988	0.0700	0.0797	0.0810	0.0794	0.0750
1500-1559	0.0912	0.0589	0.0600	0.0390	0.0756	0.0613	0.0397	0.0406
1600-1659	0.0405	0.0526	0.0165	0.0112	0.0556	0.0486	0.0126	0.0138
1700-1759	0.0202	0.0315	0.0035	0.0064	0.0407	0.0258	0.0036	-
1800-1859	-	0.0075	-	0.0016	0.0206	0.0075	-	-
1900-1959	-	-	-	-	0.0040	0.0017	-	-
2000-2059	-	-	-	-	-	0.0020	-	-
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Note: All times are expressed as Pacific Standard Time.

APPENDIX 3. ESTIMATED ANGLER EFFORT (HOURS) IN THE VEDDER-CHILLIWACK RIVER SPORT FISHERY, SEPTEMBER 1 TO DECEMBER 15, 1985 (95% CONFIDENCE LIMITS IN PARENTHESES).

	Regions 2 - 4			Region 1	All Regions
	Mean Daily Effort (hours)	Estimated Total Effort (hours)	Coefficient of Variation	Estimated Total Effort (hours)	Estimated Total Effort (hours)
September:					
Weekdays -	132.0	2,640 (792)	13.9	2,610	5,250
Weekends -	564.6	5,646 (1,292)	17.1	3,300	8,946
All days -		8,286 (1,332)	12.5	5,910	14,196
October:					
Weekdays -	588.5	12,947 (3,838)	18.8	2,196	15,143
Weekends -	978.5	8,806 (659)	9.5	3,080	11,886
All days -		21,753 (3,667)	11.8	5,276	27,029
November:					
Weekdays -	412.3	8,246 (2,231)	16.9	305	8,551
Weekends -	841.8	8,418 (1,555)	25.8	534	8,952
All days -		16,664 (2,526)	15.5	839	17,503
December:					
Weekdays -	526.7	5,267 (3,142)	30.4	125	5,392
Weekends -	803.2	4,016 (0)	22.7	150	4,166
All days -		9,283 (2,560)	19.8	275	9,558
Study Period:					
All days -		55,986 (4,909)	7.5	12,300	68,286

Note: The precision implied by the number of significant figures is overstated.
Coefficient of variation defined as the standard error divided by the estimate.

APPENDIX 4. ESTIMATED CATCH PER ANGLER-HOUR (HARVEST AND RELEASE) IN THE VEDDER-CHILLIWACK RIVER SPORT FISHERY (REGIONS 2 - 4), SEPTEMBER 1 TO DECEMBER 15, 1985.

	September		October		November		December	
	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd
A. Harvest Per Unit Effort (HPUE):								
Coho	0.0162	0.0168	0.0367	0.0204	0.0651	0.0381	0.0123	0.0236
Coho (AD)	-	-	0.0055	0.0041	0.0127	0.0087	0.0041	0.0039
Coho Jack	-	0.0101	0.0200	0.0061	0.0057	0.0087	-	-
Coho Jack (RP)	-	0.0067	0.0444	0.0260	0.0141	0.0119	-	-
Coho Jack (AD)	-	-	0.0011	-	-	-	-	-
Chinook	-	0.0017	0.0044	0.0020	-	0.0008	-	-
Chinook Jack	0.0054	0.0067	0.0077	0.0036	0.0042	-	-	-
Chinook Jack (AD)	-	-	-	0.0005	0.0014	0.0008	-	-
Pink	-	-	0.0011	-	-	-	-	-
Chum	-	0.0017	-	-	-	-	-	-
Steelhead	-	-	-	-	-	-	-	0.0039
Rainbow	0.0755	0.0151	0.0022	-	-	0.0008	-	-
Cutthroat (AD)	-	0.0017	-	-	-	-	-	-
Dolly Varden	-	0.0050	0.0033	0.0020	0.0014	-	-	-
B. Release Per Unit Effort (RPUE):								
Coho	-	0.0067	0.0055	0.0076	0.0368	0.0222	0.0777	0.0433
Coho Jack	0.0054	-	0.0133	0.0112	0.0226	0.0056	-	0.0020
Chinook	-	0.0017	0.0044	0.0010	0.0127	0.0040	-	-
Chinook Jack	0.0054	-	0.0100	0.0025	0.0028	-	-	-
Pink	0.0323	0.0151	0.0511	0.0265	0.0028	0.0016	-	-
Chum	-	0.0017	0.0711	0.0265	0.1414	0.1001	0.1636	0.0808
Steelhead	-	-	-	-	-	-	-	0.0039
Rainbow	0.0431	0.0268	0.0022	-	-	-	-	-
Dolly Varden	-	0.0034	-	0.0010	-	-	-	-

Note: Units are fish per hour.
AD = Adipose fin clipped.
RP = Right Pelvic fin clipped.

APPENDIX 5. OBSERVED AND ESTIMATED HARVEST OF COHO SALMON IN THE VEDDER-CHILLIWACK RIVER SPORT FISHERY, SEPTEMBER 1 TO DECEMBER 15, 1985.

	September	October	November	December	Total
Coho Adults					
- estimated catch	138	762	1,036	197	2,133
- observed catch	13	86	114	18	231
- percent observed	9.4	11.3	11.0	9.1	10.8
Coho Jacks					
- estimated catch	95	1,131	336	0	1,562
- observed catch	10	132	40	0	182
- percent observed	10.5	11.7	11.9	-	11.7

APPENDIX 6. ANGLER CHARACTERISTICS IN THE VEDDER-CHILLIWACK RIVER SPORT FISHERY, SEPTEMBER 1 TO DECEMBER 15, 1985.

	September		October		November		December	
	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd
A. No. Interviews	75	180	398	622	286	463	109	206
B. Mean Angler Day (hours)								
- All Anglers	3.94	5.14	4.88	5.58	5.00	5.13	4.87	5.21
- Clear Days	4.56	5.13	-	-	4.30	5.25	5.36	2.95
- Overcast Days	3.17	5.16	4.78	5.42	5.27	4.92	4.69	5.42
- Rain Days	2.50	-	5.02	5.69	4.99	4.69	4.78	5.57
- Incomplete Trip	4.03	5.25	5.03	5.72	5.04	5.18	4.87	5.38
- Complete Trip	3.58	4.52	3.78	4.31	3.00	4.07	-	2.97
- No. Incomplete	61	153	350	558	280	440	109	191
- No. Complete	14	27	48	64	6	23	0	15
C. Target Species								
- Coho	29	77	332	480	271	397	21	39
- Steelhead	0	3	1	8	2	5	38	94
- Chinook adult	1	2	0	0	0	0	0	0
- Chinook jack	1	0	0	0	0	0	0	0
- Other Specified Species	0	4	0	0	0	0	0	0
- Any Salmon or Trout	44	93	65	134	13	61	50	73
D. Gear								
- Bait	47	106	228	398	141	225	21	38
- Bait and Lure	5	14	36	54	29	58	26	53
- Fly	3	11	12	11	8	12	3	3
- Lure	20	49	122	159	108	168	59	112